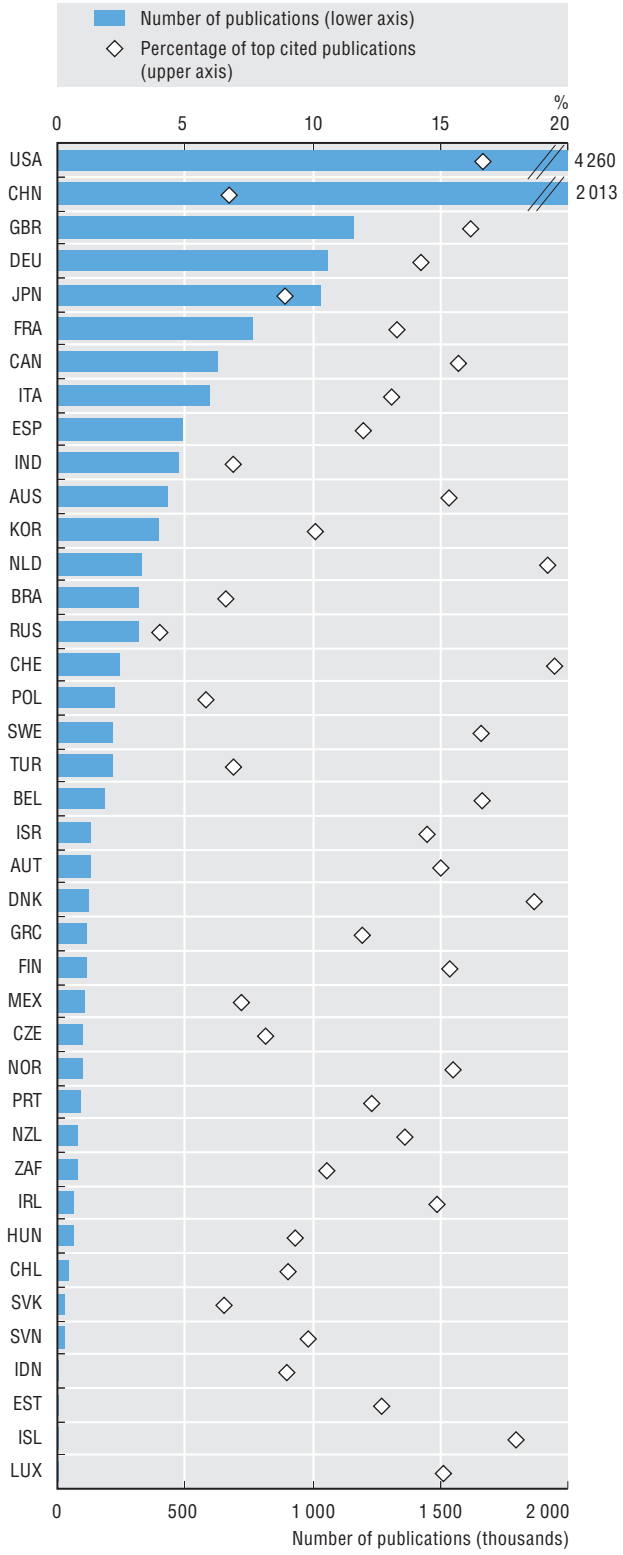
7. Research excellence

The quantity and quality of scientific production, 2003-11

Number of documents and percentage of world's top-cited



Source: OECD and SCImago Research Group (CSIC), *Compendium of Bibliometric Science Indicators 2014*, based on Scopus Custom Data, Elsevier, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891568

Top-cited publications provide a measure of "quality-adjusted" research output. The United States led the production of scientific publications over 2003-11. Although China accounts for the second largest number of scientific documents, it lags the United Kingdom and Germany in terms of numbers of highly cited documents. Switzerland has the largest share of documents with a high citation impact among domestic publications, closely followed by the Netherlands and Denmark.

Top-cited publications are more likely to involve scientific collaboration across institutions (international and domestic) than "average" publications. The collaboration gap is particularly large for the Russian Federation, Poland, the Slovak Republic and Estonia.

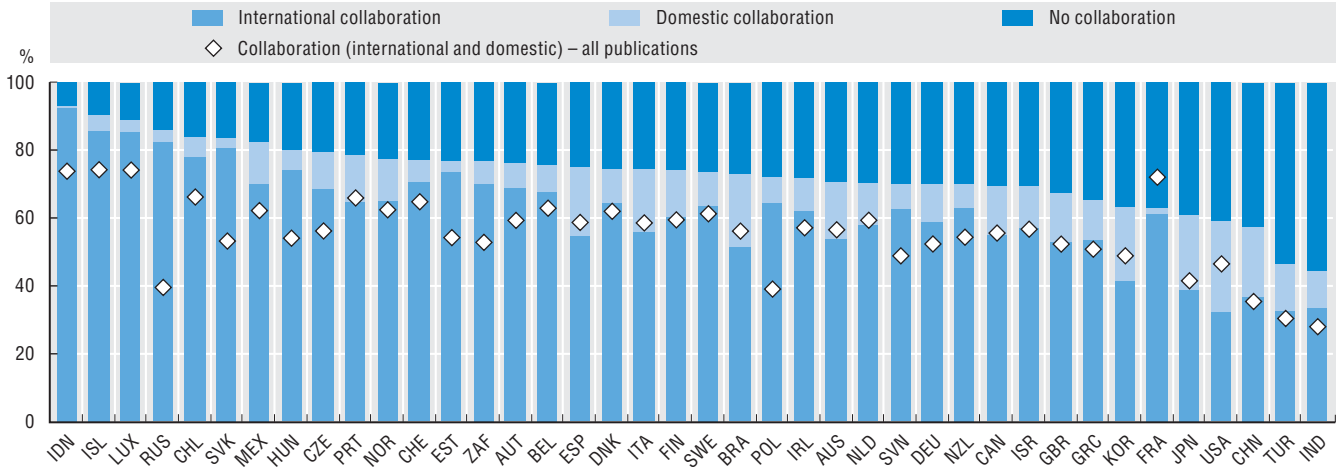
International collaboration rates and average impact are highly correlated. Countries with high shares of top-cited publications tend to have higher collaboration rates. Exceptions include the United States (high impact but low collaboration) and Indonesia (low impact but high collaboration). International collaboration appears to allow countries to attain higher citation impact rates than they would otherwise achieve. For many, this involves participating in projects led by experts in centres of excellence located abroad. Adjusting counts of high-impact documents for documents with a non-resident corresponding (i.e. leading) author would significantly reduce most economies' share of top-cited publications. For example, in Switzerland, the share would drop from nearly 20% to 10%. However, for the United States, the adjustment is fairly minor, from 17% to 14% of domestic publications. It is therefore the economy with the largest share of high-impact, domestically led documents, followed by the Netherlands and the United Kingdom. This suggests that authors from these countries are more likely to feature as leading authors in international collaborations.

Definitions

Estimates of scientific production are based on whole counts of documents by authors affiliated to institutions in each economy. The number of *top-cited publications* is an indicator of *research excellence* and represents the 10% most-cited papers in each scientific field. *Collaboration* is defined at the institutional level. A scientific document is deemed to involve collaboration if multiple institutions are listed in the affiliations of the author(s). Top-cited publications attributed to a given economy are defined as having a *domestic leading author* when the document's corresponding author is affiliated to a domestic institution.

Top-cited publications, by type of collaboration, 2003-11

As a percentage of top-cited and all documents, whole counts

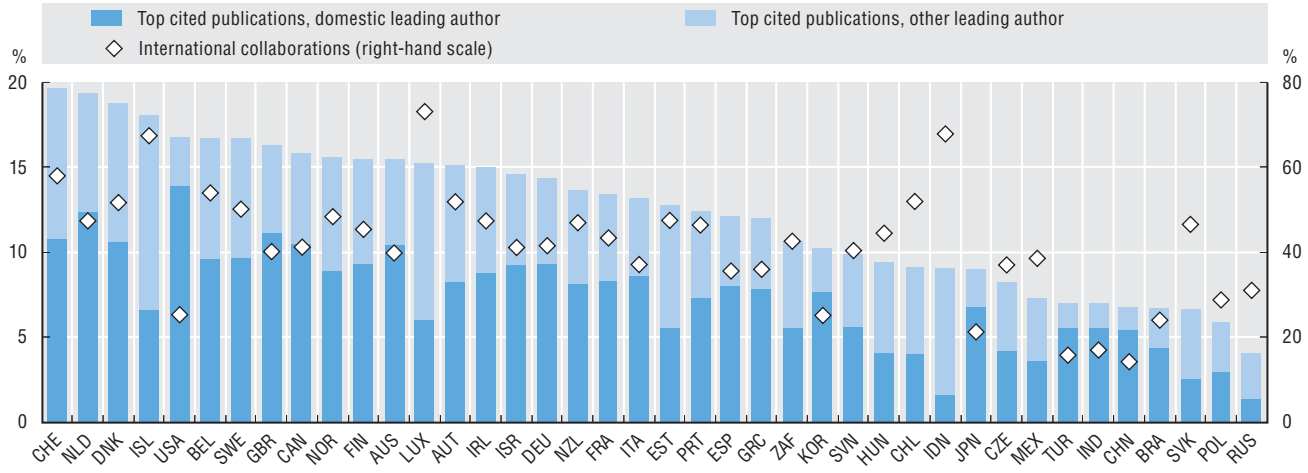


Source: OECD and SCImago Research Group (CSIC), *Compendium of Bibliometric Science Indicators 2014*, based on Scopus Custom Data, Elsevier, May 2013.
See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891587

The quality of scientific production and international collaboration, 2003-11

As a percentage of scientific publications



Source: OECD and SCImago Research Group (CSIC), *Compendium of Bibliometric Science Indicators 2014*, based on Scopus Custom Data, Elsevier, May 2013.
See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891606

Measurability

Peer-reviewed scientific publications convey the research findings of scientists worldwide. Subsequent citations by other authors provide an indirect but objective source of information about the quality of research outputs. This does not however take into account the use of the scientific information by inventors or practitioners who are less likely to publish in peer-reviewed journals. Publications are attributed to countries on the basis of the authors' institutional affiliations. This requires a means of counting publications with co-authors from different units. One approach is to fractionalise publications by contributing units, so that reported figures add up to the total number of publications (each document has the same weight). An alternative is to report total counts per unit (the whole counts approach), which gives equal weight of one to each of the document's authoring units. Although the choice does not much affect country rankings, care should be exercised when interpreting either type of results. An alternative is to attribute the entire document to its leading author's affiliation using information on the identity of the corresponding author (Moya-Onegón et al., 2013).

Notes and References

Cyprus

The following note is included at the request of Turkey:

"The information in this document with reference to 'Cyprus' relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognizes the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the 'Cyprus issue'."

The following note is included at the request of all the European Union Member States of the OECD and the European Union:

"The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus."

Israel

"The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities or third party. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

"It should be noted that statistical data on Israeli patents and trademarks are supplied by the patent and trademark offices of the relevant countries."

3.1. R&D and knowledge flows

Business enterprise R&D funded by other companies, 2010

Data refer to 2010 except for Austria (2009), Brazil (2009), the Czech Republic (2011), Denmark (2009), Iceland (2009), New Zealand (2009), Norway (2011), South Africa (2009), Sweden (2009), Switzerland (2008) and the United States (2009).

Reported funding by other firms includes funding from other domestic enterprises that are part of the same group, except for Finland and New Zealand.

For Brazil, data on the share of BERD funded by industry are not available.

Business funding of extramural R&D, by type of performer, 2010

Data refer to 2010 except for Austria (2009), Belgium (2009), the Czech Republic (2011), Germany (2009), New Zealand (2009), Norway (2011), Sweden (2009), Switzerland (2008) and the United States (2009).

"Other" includes funding to non-business institutions, both domestic and abroad. For Germany and Japan, it also includes funding to enterprises abroad.

For the Czech Republic, Estonia, Italy, Korea, the Slovak Republic, Spain and Turkey, reported data exclude funding by non-R&D performers.

Business-funded R&D in the higher education and government sectors, 2001 and 2011

For Australia, data refer to 2000 and 2008 instead of 2001 and 2011.

For Austria, data refer to 2002 and 2009 instead of 2001 and 2011.

For Belgium, Iceland, Israel, the Netherlands and South Africa, data refer to 2009 instead of 2011.

For Chile, EU28, France, Germany, Italy, OECD, Portugal and Spain, data refer to 2010 instead of 2011.

For China, data refer to 2000 instead of 2001.

For Switzerland, data refer to 2000 and 2010 instead of 2001 and 2011.

3.2. Open innovation

General notes for all figures:

For Australia, data refer to financial year 2010/11 and include product, process, marketing and organisational innovating firms (including ongoing or abandoned innovation activities).

For Brazil, data refer to 2006-08. Only the following activities are included in the services sector: ISIC Rev.4 Divisions 58, 61, 62 and 72.

For Chile, data refer to 2009-10 and to firms with more than UF 2 400 in annual revenue. Data include product, process, organisational and marketing innovating firms. Ongoing or abandoned innovative activities are not identified. The industries covered are based on ISIC Rev.3.1 and include a wider range of activities than the CIS, such as agriculture, forestry, fishing, construction and some services.

For Israel, data refer to 2006-08.

For Japan, data refer to financial years 2009/10 and 2010/11. Data are provisional estimates.

For Korea, data refer to 2005-07 and to firms with more than 10 employees in the manufacturing sector.

For Mexico, data refer to 2008-09 and to firms with 20 or more employees. The industries covered are based on ISIC Rev.3.1 and include a wider range of activities, such as agriculture, construction and some services.

For New Zealand, data refer to financial years 2009/10 and 2010/11, and to firms with six or more employees with an annual goods and services tax (GST) turnover figure greater than NZD 30 000. Data refer to product, process, organisational and marketing innovating firms (including ongoing or abandoned innovation activities).

For the Russian Federation, data refer to 2009-11 and to firms with 15 or more employees. The industries covered are based on NACE Rev.1.1 and include manufacturing (D), and services (64, 72, 73, 74).

For South Africa, data refer to 2005-07 and to firms with 20 or more employees, with a minimum turnover of between ZAR 3 million and ZAR 6 million depending on the industry. Data also include the retail trade sector.

For Switzerland, data refer to 2009-11. Collaboration only refers to collaboration on R&D.

Additional notes:

External sources of knowledge for innovation, by type, 2008-10

In the Australian questionnaire it is only asked whether the relevant source was used, not the degree of importance of the source.

For Germany, Israel, Luxembourg, the Netherlands and Switzerland, data refer to 2006-08.

In the New Zealand questionnaire, sources of information are defined as important, rather than highly important.

3.3. Collaboration on innovation

General notes for all figures:

See under 3.2.

Additional notes:

Firms engaging in collaboration on innovation, by R&D status, 2008-10

For Luxembourg, data refer to 2006-08.

For Spain, R&D status corresponds to 2010 only.

Firms collaborating on innovation with higher education or public research institutions, by firm size, 2008-10

For Ireland, Israel and Luxembourg, data refer to 2006-08.

For Mexico, data refer to collaboration with higher education institutions only.

3.4. International collaboration

General notes for all figures:

See under 3.2.

Additional notes:

National and international collaboration on innovation by firms, 2008-10 and Firms engaged in international co-operation, by firm size, 2008-10

For Ireland and Luxembourg, data refer to 2006-08.

International collaboration on patents, 2007-11 and innovation, 2008-10

International co-inventions are measured as the share of patent applications filed under the Patent Cooperation Treaty (PCT) with at least one co-inventor located in a different country in total patents invented domestically. Patent counts are based on the priority date, the inventor's country of residence and whole counts.

3.5. Skills mobility

International and foreign students enrolled in tertiary education, 2011

Data refer to foreign students for the Czech Republic, France, Israel, Italy, Poland, the Slovak Republic and Turkey. Foreign students are defined on the basis of their country of citizenship; these data are not comparable with data on international students and are therefore presented separately in the table and chart.

Total enrolments include all international or foreign students. Distribution is based on the number of students with a known field of education.

Data for Austria, Finland, Germany and Switzerland exclude tertiary-type B programmes.

Data for Canada and Luxembourg refer to 2010.

Data for the Netherlands exclude programmes in private education.

Labour turnover, by educational attainment, 2011

With the exception of the United States, the indicator for all employed individuals is computed on the basis of the OECD Job Tenure Database as a share of declared figures for total employed (dependent employees and self-employed) of all age groups. Estimates by level of educational attainment are based on an *ad hoc* tabulation of European Labour Force Survey data and computed on a similar basis.

For the United States, data refer to the share of all wage and salary workers aged 16 and over with a year or less of tenure with their current employer in January 2012.

Tertiary education refers to individuals who have graduated from tertiary education (ISCED 5 and 6 levels); low or no formal education refers to individuals with at most lower secondary education (ISCED 0, 1 and 2 levels).

For Australia and Canada, data refer to 2010.

For Brazil, data refer to 2009.

For Mexico, data refer to 2008.

Doctorate holders who changed jobs in the last ten years, 2009

For Belgium, Hungary, the Netherlands and Spain, data refer to graduates only from 1990 onwards.

For the Russian Federation, data refer only to those doctoral graduates employed as researchers and teachers.

For Spain, there is limited coverage of graduates who received their doctorate between 2007 and 2009.

EU15 total employment mobility is computed on the basis of the OECD Job Tenure Database and corresponds to the share of 25-69 year-old employed individuals who have changed jobs in the last ten years.

3.6. Researchers on the move

International flows of scientific authors, 1996-2011

The minimum threshold for inclusion is over 2 000 bilateral flows.

General note:

International mobility of scientific authors, 1996-2011 and;

Impact of scientific authors, by category of mobility, 1996-2011

The minimum threshold per economy is over 25 000 scientific authors in the stayer category.

Additional note:

Impact of scientific authors, by category of mobility, 1996-2011

International mobility of scientific researchers is inferred from authors listed in the Scopus Custom database of peer-reviewed scientific publications, with at least two documents over the reference period, based on changes in the location of their institutional affiliation. Stayers maintain an affiliation in a given reference country over the period. Outflows are defined on the basis of the first affiliation. New inflows are defined on the basis of the final affiliation and exclude individuals who "return" to their original country of affiliation. The latter group are defined as "returnees".

A proxy measure of scientific impact for researchers with different mobility patterns is estimated by calculating, for each author and mobility profile, the median across the relevant journals' source-normalised impact per paper (SNIP) over the entire period. A SNIP impact value that is higher than one means that the median attributed SNIP for authors of that country/category is above average.

3.7. Research excellence

General note for all figures:

Estimates are based on whole counts of documents by authors affiliated to institutions in each economy.

3.8. Science for innovation

General notes for all figures:

The link between patents and scientific literature is based on the non-patent literature (NPL) listed as relevant references in patent documents in the Thomson Reuters Derwent World Patents Index and Derwent Patents Citation Index databases. It is applied to patents in selected technology areas, based on the International Patent Classification (IPC) codes in the patent document.

In order to identify whether NPL corresponds to a scientific document, NPL references were matched to the Thomson Reuters Web of Science Database, an index of scientific literature. For matched references, scientific domains correspond to the Thomson Reuters Essential Science Indicators 22-field classification (*http://archive.sciencewatch.com/about/met/fielddef/*). Geographical attribution of scientific documents is based on the document's author's affiliation, using a "whole counts" approach.

Only the main scientific domains accounting for 90% of total patent citations to the scientific literature are reported.

Additional notes:

Main sources of scientific documents cited in patents, selected technology areas, 2001-11

Patents in health-related technologies comprise medical technologies and pharmaceuticals. The list of environment-related patent codes is available at *www.oecd.org/env/consumption-innovation/indicator.htm*. The list of biotechnology and ICT-related patent codes is available at *www.oecd.org/sti/inno/40807441.pdf*. Nanotechnology-related patents are defined as those with IPC codes B82B and B82Y.

Main scientific sources of biotechnology, nanotechnology and ICT patents, 2001-11

The list of biotechnology and ICT-related patent codes is available at *www.oecd.org/sti/inno/40807441.pdf*. Nanotechnology-related patents are defined as those with IPC codes B82B and B82Y.

Main scientific sources of health and environment-related patents, 2001-11

The link between health-related patents and scientific literature is applied to patents in medical technologies and pharmaceuticals following the classification presented in Schmoch (WIPO, 2008, revised in 2013).

The list of environment-related patent codes is available at *www.oecd.org/env/consumption-innovation/indicator.htm*.

3.9. From knowledge to inventions

General notes:

Patents citing non-patent literature by technology field, 1997-2002 and 2007-12 and;

Patents citing non-patent literature, selected technologies, 1997-2002 and 2007-12

Data refer to the citations made in patent applications filed at the European Patent Office (EPO), according to the publication date of the citing patent, the applicant's residence and fractional counts.

Additional notes:

Patents citing non-patent literature by technology field, 1997-2002 and 2007-12

Only economies with more than 500 patents in 2007-12 are included in the figure. Patents are allocated to technology fields using International Patent Classification (IPC) codes, following the classification presented in Schmoch (2008, revised in 2013).

Patents citing non-patent literature, selected technologies, 1997-2002 and 2007-12

Patents are allocated to technological fields using the International Patent Classification (IPC) or the European Patent Classification (ECLA).

Citations to patents that include non-patent literature, by technology fields, 2007-12

Data refer to the citations made in patent applications filed at the European Patent Office (EPO), according to the publication date of the citing patent. Forward citations of patents refer to patents with NPL backward citations that are cited as particularly relevant documents (I, X, Y) by EPO patents up to five years after the first publication. Patents are allocated to technology fields using International Patent Classification (IPC) codes, following the classification presented in Schmoch (2008, revised in 2013).

3.10. Inventions across borders

International co-inventions in patents, 1999-2001 and 2009-11

International co-inventions are measured as the share of patent applications filed under the Patent Cooperation Treaty (PCT) with at least one co-inventor located in a different economy in the total patents invented domestically. Patent counts are based on the priority date, the inventor's residence and fractional counts. Only economies with more than 250 patents in 2009-11 are included.

International co-inventions by technology fields, 1999-2001 and 2009-11

International co-inventions are measured as the share of patent applications filed under the Patent Cooperation Treaty (PCT) with at least one co-inventor located in a different country in total patents. Patents are allocated to technology fields using International Patent Classification (IPC) codes, following the classification presented in Schmoch (2008, revised in 2013). Patent counts are based on the priority date and fractional counts by technology fields.

Foreign inventions owned by economies, 2009-11

Data refer to counts of patent applications filed under the Patent Cooperation Treaty, by priority date, applicant's residence and fractional counts. Foreign inventions owned by economies relate to the share of patents owned by a resident of an economy for which no inventors reside in the given economy, as a share of total patents owned by that economy. Only economies that applied for more than 250 patents over the period are included.

3.11. Technology flows and markets

International technology flows of royalties and licence fees, 2000-11

For Belgium and the Russian Federation, data refer to 2003-11.

For Denmark and Indonesia, data refer to 2005-11.

For the Netherlands, data refer to 2004-11.

For Norway, data refer to 2000-10.

For Italy, data refer to 2000-07.

OECD excludes Iceland, Mexico and Turkey.

Revenues of specialist intellectual property leasing firms, 2010

For European countries, revenue estimates correspond to firms in NACE Rev.2 sector 774 ("Leasing of intellectual property and similar products, except copyrighted works"). For the United States, estimates correspond to NAICS sector 533 ("Lessors of nonfinancial intangible assets – excluding copyrights"). Revenue estimates are divided by INTAN-Invest estimates of business sector investment in "new intangible assets" (R&D, design, new financial products, advertising, market research, training and organisational capital). This category approximately corresponds to the products within the scope of the IP leasing sector.

Royalty income by industry, United States, 1999 and 2009

Data on royalties and revenues (receipts) from the United States Internal Revenue Service's Statistics of Income (SOI), Table 6 – Returns of Active Corporations, Form 1120, *www.irs.gov/uac/SOI-Tax-Stats-Returns-of-Active-Corporations-Table-6*, "Balance Sheet, Income Statement, Tax, and Selected Other Items, by Major Industry". Figures are estimates based on samples. Last accessed June 2013.

Only the 23 industries with the highest royalty income are reported. For 2009, Broadcasting and telecommunication is calculated as the sum of Broadcasting except Internet and Telecommunication (including paging, cellular, satellite, cable, internet, service providers, etc.). For 2009, Information and data processing services were calculated as the sum of Data processing services and Other information services.

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